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ASIAN-PACIFIC COOPERATION IN SPACE TECHNOLOGY AND APPLICATIONS

by

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ABSTRACT

Along with the polycentralization of the international economy and regional realignment, the Asia-Pacific economy continuing to thrive and prosper. The demands for resources exploration and development and for environmental monitoring and protection using space technology are increasing. Especially since the United Nations Environmental and Development Congress held in Rio de Janeiro of Brazil, many countries have adopted their own action programs based on the Agenda 21. In accordance with the two themes on Development and Environment of global concern, many countries and international organizations in the Asia-Pacific region have been adopting new policies and are participating in and appealing for international cooperation in space technology. Whether or not they have space technology capabilities, these countries have expressed a common aspiration of making full use of the potential of space applications to improve sustained social and economic development in the region.

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FORWARD

This paper was written at the request of the United Nations Developmental Planning Office and the Asian-Pacific Economic Conference. It was completed early in 1994 under the leadership of professors Lin Quan and Zeng Lizhong of the China National Remote Sensing Center. It was also written with the guidance and support of Academy of Sciences scholars Wang Daheng and Chen Fangyun as well as more than 30 experts from the National Science Commission, National Weather Bureau, National Maritime Bureau, National Cartography Bureau, China Academy of Sciences and Ministry of Water Resources. Because it was written some time ago, some of the data is not the most recent.

I. Cooperation in international resources satellite technology and information sharing

In China there are more than 460 units and almost 10,000 scientific and technical personnel directly engaged in or participating in practical research, testing and production of remote sensing satellites. More than 100 remote sensing image processing systems have been development for these satellites. More than 10 provincial (region) and municipal level remote sensing application centers have been established. Since the seventies, more than 200 million U.S. Dollars have been invested (there are incomplete statistics).

In the seventies, China's primary satellite remote sensing information source was the Landsat-MSS data. In 1986, after construction of the China remote sensing satellite ground station, it primarily used data from Landsat-TM, and a small amount of data from imported from the Sparta satellite, the Japanese Earth Remote Sensing Satellite-1, the European Remote Sensing Satellite-1, the

space shuttle and the former Soviet Union satellite data and Nuo'a (phonetic) weather satellite. From the middle seventies to the present time, China has developed 35 satellites of different models. These include the capture of remote sensing data, primarily relying on recoverable satellites, and also including seven survey type scientific experiment satellites, to national survey satellites, one scientific experimental satellite with a resolution of five meters, three photographic positioning satellites and two polar weather satellites (Fengyun-1). Prior to October of 1994 China planned to launch five satellites, including two recoverable scientific experiment and technology exploration satellites, the Fengyun-2, weather satellite, the Dongfanghong-3 communications satellite and the Shijian-4 scientific experiment satellite, and to use high-capability recovery to recover the recoverable satellites to bring back to earth scientific experiment and technological exploration data obtained in space. The Fengyun-2 was the first stationary weather satellite developed by China. The Shijian-4 will carry out atmospheric physics testing using new processing capabilities, and the Dongfanghong-3 uses earth synchronous orbit and triaxial stability. It has large volume, a long life, and is highly precise, providing the broadcast industries with information services. It is predicted that between 1994 and 2000 China will launch between 25 and 30 foreign satellites.

China's remote sensing satellite earth station was built five years ago, and since that time has provided China and foreign customers with about 3000 Landsat TM images. In the world market, each image costs 4,300 U.S. Dollars. Domestic customers are only charged one-fourth or one-fifth of this, with state subsidies for public good remote sensing satellite materials, thus bringing satellite remote sensing information for geological mapping down to about one-third conventional methods, and cutting the production

cycle in half. Using this information for other resource exploration and environmental monitoring can also reduce the cost one-third to one-thirteenth. For regions which have not been surveyed and with special environmental conditions, it can be reduced one-ninth to one-360th (estimates of the Thailand Remote Sensing Center).

It will probably not be possible to realize commercialization of satellite system products during this century, and satellite remote sensing information will gradually become accepted within the marketplace. The United States EOSAT Corporation has not been able to do without support of the Department of Commerce. The French Sibote (phonetic) Imaging Corporation recovered 80 percent of ground investment in 1990. The concentration of remote sensing satellite ground stations is heaviest in the Asia-Pacific region. There are ten LANDSAT earth receiving stations in addition to the five in North American, two in South America and one in Australia. The overlapping coverage is greatest here, and leases and maintenance costs are considerable. We need to have cooperation among countries, strive for favorable treatment for countries launching remote sensing satellites, and work together to solve the problems of the price competition in the marketplace.

II. International sharing of weather satellite information

The application of weather satellite information has been expanded from weather itself to many aspects of earth environmental monitoring. Not only has it been opened up to nations which do not possess weather satellites, but their rapid coverage of the earth and short cycle have made them primary information sources for world-wide changes and natural disaster monitoring. For example, typhoon formation and locating, strength estimates, storm weather system life cycle (only a few hours, with a scope of no more than

a few hundred kilometers), aerosols in the atmosphere, the existence of trace gasses, snow coverage, extent of flooding, vegetation cover index and crop growth monitoring have all had success in a number of countries in the Asia-Pacific region. The 1987 monitoring of the forest fires in Northeast China, the crop estimates for wheat in North China areas since 1988 were both praised by the Chinese Government. This is especially true for high resolution digital information which provides a good deal of effective information for monitoring the dynamics of physical fields in the atmosphere and on the earth and in fire prevention and disaster reduction. China has also had many successful experiences in analyzing signs indicating an earthquake is about to occur, monitoring of red tides, and monitoring water and air pollution.

The data receiving and image management systems for the weather satellite's designed and developed by China also make wide use of receiving and utilizing foreign weather satellite data. While participating in international cooperation activities of the World Weather Organization, China has actively developed its won weather satellites. In 1988 and 1990 China launched two polar weather satellites, obtaining high quality cloud pictures. China is also preparing to launch a stationary weather satellite in 1994 which will be stationary above the equator at 105° East Longitude. The information it collects will be shared among the nations and regions of the Asia-Pacific region. With the nearing of the economic and trade society, the sharing of fundamental materials and data within the Asia-Pacific region has already become a necessary trend in scientific and technological development.

III. Networking of satellite communications

More than 120 civilian communications satellites have been

launched around the world so far in synchronous orbit at 36,000 meters and are being used by more than 150 countries. These represent two-thirds of the total number of international communications circuits, and more than 5,000 channels have penetrated various aspects of communications within all countries. China uses the INTELSATs over the Indian Ocean and the Pacific Ocean for 3,500 channels to connect with 47 countries on five continents and relays to all nations of the world. In addition to the current eight A model standard ground stations, INTELSAT has set up the INTELSAT control station for he Indian Ocean and Pacific Region and the TEMA reference station in Beijing

China's communications satellites space resources has also been greatly increased. Since the eighties China has launched six satellites she developed herself, as well as the Asia-1 and China-5 (purchased in orbit from the United States) as well as leasing and purchasing relays from INTELSAT, now numbering 40 relays. Soon four or five satellites including the Asia-Pacific-1 and Asia-Pacific 2 will also be launched.

In satellite communications applications, China has drafted a series of test point plans, and currently there are about 40,000 satellite television receiving stations and almost 100,000 home television receiving stations. There are 10 sets of satellite broadcast programming, and about 80 percent of China's population is under satellite television's footprint, providing effective service to areas in the hinterlands and to minority nationalities. There are currently two sets of educational television programming, providing 30 hours of educational television daily, and the more than 500 receiving and relay stations and more than 500 receiving stations, this allows 1.2 million elementary and middle school teachers to receive standard class work, and six million people to receive on-the-job training and 20 million farmers to view

programming useful in agricultural villages and towns. This has played an important part in improving the level of teaching, expanding cultural education to border regions and promoting regional economic development.

Very small aperture terminal (VSAT) system applications have developed very rapidly. The Peoples Bank of China has already built a network of 200 sub-banks. There is a tremendous potential for use by the railroad and water transport systems, where it could possibly improve efficiency by 30 to 40 percent. In order to meet the needs of television situation relays and emergency communications, China already has nearly ten 2.4 meter Ku band the and 7.2 meter C band portable ground satellite stations, and city pager networks have already gone into commercial operation.

Burma, Thailand and Pakistan are now establishing networks of satellite communications ground stations. In 1988 and 1991 the United Nations convened in China an "International symposium the Applications of International Communications" and an "International symposium on Using Space Technology Against Natural Disasters". In 1993 it convened in Australia an "International Symposium on Space Applications". At all of these meetings there was helpful exchange of technology on satellite television educational systems and small satellite communications systems. China is willing to provide the necessary technical support for this.

IV. Expanded applications of the Global Position System

The global positioning system is a second generation satellite guidance system developed by the U.S. military at a cost of more than three billion U.S. Dollars. After 15 years, it was established ahead of schedule in June of 1993. It is composed of 21 satellites and three reserve satellites. At any location around

the world at least four satellites will provide coverage 24 hours a day. The United States has publicly announced that when this system is completed, it will have an SA (only to selected customers) and AS (anti-deception) policy, and artificially reduce the GPS broadcast precision to less than 100 meters. It will also limit use of P-code (or Y code) to the United States and its allies (P-code ranging precision is about 0.3 meters, ten times as precise as C/A code ranging).

The Asia-Pacific region is one where a number of plates connect, and there are frequent earthquakes and crust movement is extremely active. There needs to be cooperation to establish a GPS network composed of six or seven tracking stations and corresponding data processing centers. Through comprehensive processing and calculation, it will be possible to obtain a GPS satellite accuracy of one to two meters and false ranging correctors for use by countries in Asia and the Pacific. This could improve the relative position accuracy and data management efficiency, overcoming the problem that the United States could change the operating mode of its satellites at any time, and could assist in photographic cartography in mountainous and desert regions where there are no control points, reducing the amount of field operations. Under usual circumstances, when ranging is 500 kilometers or less, precision could be down to five meters, where it could basically meet the requirements of aviation, ocean navigation, railroads and highways as well as rescue operations.

V. Development of maritime satellites and miniature satellite groups

In 1973 the United States Space Laboratory equipped the first microwave scatterometer. It had altitude detection and microwave scatterometer capabilities. In 1978 the United States launched the

Maritime-A satellite, equipped with radar altimeter (ALT), scatterometer (SASS), sweep multiple channel microwave scatterometer (SMMR) and synthetic aperture radar (SAR). It could provide 24 hour, all-weather quantitative world-wide maritime information such as winds, wave heights, wave frequency, surface temperature, atmospheric layer water content, icebergs, and maritime water levels. Precision had already reached practical demands, marking the energy of ocean monitoring into the space age. The former Soviet Union also launched a number of ocean satellites. In 1987 and 1990 Japan launched an ocean satellite, used to obtain data on the continental shelf waters for developing of ocean biological resources and for environmental protection. In the next few years every country will also have a series of ocean satellites in service,. and most will be related to world cooperative projects in world ocean research, such as tropical oceans and world-wide atmospheric research, the world ocean environment experiment and research into world ocean energy.

Small earth observation satellites can, on one hand divide cooperative tasks into a number of parts, with each part carried out by a small satellite to reduce costs. On the other hand, they can also be used as multiple satellite systems to reduce the cycle between observations. For example, the small weather satellite of the United States Optical Spectrum Corporation need only be equipped with a very high resolution radiometer (AVHRR), and it would be able to obtain three dimensional cloud images and other ocean and land factors. These satellites only weight 159 kilograms (350 pounds). The French Matela (phonetic) Corporation has a ocean color doppler observation satellite which only weights 200 to 300 kilograms.

For high altitude physics and astronomical observation, the United States launched more than 50 satellites and China will

launch its "Shijian-4" (phonetic) satellite to detect charged ions and plasma between 200 and 36,000 kilometers. These satellites only weigh 400 kilograms, all belonging to the small satellite series.

Detection of natural disasters and monitoring environmental changes both require a very high surface resolution (around 30 meters) and a short coverage cycle (twice a day). Professor Chen Fangyun and others have proposed a scheme of using seven small satellites to meet these requirements. This would not require a large investment, but would be highly effective. These satellites would weigh between 200 and 250 kilograms. There have been recent proposals to use low orbit small satellites to provide around the world coverage for mobile communications such as the Motorola Corporation's system which calls for 66 satellite at an altitude of 780 kilometers and their corresponding ground system. This system's communications system will use time division multiplexing (TDMA) technology. The "Laola/Kaer" (phonetic) Corporation's world-wide uses 48 satellites at an altitude of 1400 kilometers, and this communications system uses time domain multiplexing/frequency division/code division multiplexing (TDD/FD/CDMA) TECHNOLOGY. China has proposed a mobile communications system composed of medium earth orbit (MEO) satellites. The mobile customers would have a high angle to the satellite, and earth object obstruction would be low. It would provide world-wide coverage with a smaller number of satellites. It is called a global mobile satellite information system (GMSIS).

Small satellites work together with large satellites, and they are also in competition with large satellites. A new generation of small satellites will be developed very quickly. They will be better suited to the requirements of batch production and multiple consumers. They will provide a new opportunity for developing

nations to participate in the utilization of space. Small satellites can be carried into space or a number can be placed aboard a single rocket.

6. Space environment experiments and exploration

Japan and China have launched research into the low gravity of space. Mongolia and Vietnam also took part in low gravity experiments with the former Soviet Union. Since 1987 China has used recoverable satellites to perform more than 30 material and more than 200 biological experiments, and has also developed high altitude balloon low gravity capsule technology, with a 20 meter drop tube and seven meter quartz drop tube equipment. Gallium arsenide transistor material grown in space has markedly superior qualities and when used as integrated circuit chip material has greatly improved computational speed and anti=radiation properties. However, its problems of uneven high resistance and low resistance still needs to be solved. In addition, China has also conducted a number of different alloy processing, protein crystal growth, carried microorganisms and different types of seeds into space. Mutations caused by space environments in paddy rice, tomatoes and green peppers have already been planted. All this will serve to promote protein engineering, medicine, biological chip production and new types of plants.

German and French companies have both participated in China's satellite experiments, obtaining excellent results. This has made it easier to provide these results to the nations in Asia and the Pacific.

The Chinese Academy of Sciences has established a low latitude space exploration rocket launch base on Hainan Island, and has developed two rockets. These are the Zhinu-1 which weighs 62

kilograms, has an effective payload of 4.8 kilograms and a maximum altitude of 70 kilometers; and the other rocket is the Zhinu-3 which weights 282 kilograms, has an effective payload of 25 kilograms and a maximum altitude of 147 kilometers. These have been successfully launched a total of 22 times. At the present time negotiations are ongoing with the Indonesian Academy of Space to use these rockets in a cooperative venture or to transfer this technology.

Since 1977 Chins's Academy of Sciences has launched more than 170 high space balloons with a maximum altitude of over 40 kilometers. The volume of the balloon from 10,000 to 400,000 cubic meters and a load of more than 500 kilograms. It has cooperated with Japan to carry out transoceanic flight of these balloons, and has cooperated with Russia in long distance (greater than 5000 kilometers) flight. In countries with westerly winds, medium and high latitude nations these balloons have been used to conduct atmospheric observation of the wind flows and monitoring for natural disasters. These have also been effective in monitoring for the spread of wind-borne loess and volcanic ash.